University of Bahrain
College of Information Technologies
Department of Computer Engineering
Test 2 – All Sections
ITCE 311/ITCE 352: Introduction to Networking
Semester 1, 2014-2015
Instructor: Dr. Ebrahim Abdulrahman

Date: December 7th, 2014	**Student Name:**
Time: 1 Hour	**Student No:**
Section No:	

– Make sure you have 5 pages with 3 parts of questions –

Question	Points	Points Attained
Part I	**21**	
Part II	**12**	
Part III	**8**	
Total	**40**	

Notes:

- **Cellular phone is not allowed.**
- **The following formulae may be needed in the questions:**

1. **Bitrate** $= 2 \times B \times log_2 L$.
2. $\mathbf{C} = B \times log_2 (1 + SNR)$.
3. $\mathbf{dB} = 10 \times log_{10} \frac{P2}{P1}$.

Part I: Read the questions carefully then answer all the questions [hint: show your step-by-step answer process to improve your grade score] (out of 21): [3 points each]

1. Assume that a channel occupies a bandwidth of 4 MHz. We need to multiplex 20 channels with guard bands of 250 kHz. What is the minimum required bandwidth?

   Sol:

   Frequency of total channels → $4 \times 20 = 80\ MHz = 80,000\ kHz$ ---------- 1 mark

   Frequency of total guard bands → $250 \times 19 = 4750\ kHz = 4.75\ MHz$ ---------- 1 mark

   Minimum required frequency → $80 + 4.75 = 84.75\ MHz = 84750\ kHz$ ---------- 1 mark

2. Four channels each with data rate of 2 M bytes per second need to be multiplexed together using synchronous TDM with a synchronous bit added to each frame. The interleaving is 7 bits. What is the output frame rate?

   Sol:

   2 M bytes per second = $16\ Mbps$ ---------- ½ mark

   Output rate = $16 \times 4 = 64\ Mbps$ ---------- ½ mark

   Frame size = $(7 \times 4) + 1 = 29$ bits ---------- 1 mark

   Output frame rate = $\frac{64}{29} \cong 2.2\ M\ frame\ per\ second$---------- 1 mark

   [Can be solved in other ways as well]

3. Nine channels need to be multiplexed together using statistical time division multiplexing. What is the minimum number of bits required for the address field in each output slot?

   Sol:

   Minimum number of bits required for the address field in each output slot is:

   $\lceil log_2\ 9 \rceil = 4$ bits ---------- 3 mark

4. Four channels, each creating 100 characters per second are to be multiplexed together using statistical TDM using character interleaving. What is the input time slot in ms?

   Sol:

   100 char per second = 800 bps ---------- 1 mark

   Input time slot = $\frac{Input\ data\ unit}{Input\ data\ rate} = \frac{8}{800} = \frac{1}{100}\ s$ ---------- 1 mark

   Input time slot in ms → $1000 \times \frac{1}{100} = 10\ ms$ ---------- 1 mark

5. We need to use synchronous TDM and combine 10 digital sources, each of 100 bytes per second. Each output slot carries 2 bits from each digital source. What is the output frame rate?

   Sol:

   Output data rate = 1000 Bps = 8000 bps ---------- 1 mark

   Frame size 20 bits ---------- 1 mark

   Output frame rates = $\frac{8000}{20} = 400\ frame\ per\ second$ ---------- 1 mark

6. Three channels, one with a bit rate of 125 kbps and two with a bit rate of 250 kbps are to be multiplexed together using TDM with no synchronization bits. The interleaving is 1 char. What is the size of the frame in bits?

Sol:

No. of channels = 5 ---------- **1 mark**

Frame size = 1 char × 5 channels = 5 chars ---------- **1 mark**

Frame size in bits → $5 \times 8 = 40\ bits$ ---------- **1 mark**

7. Five channels, three with a bit rate of 45 kbps and two each with a bit rate of 90 kbps are to be combined using multiple slot TDM with no synchronization bit. The interleaving is 3 bits. What is the output time slot?

Sol:

No. of channels = 7 ---------- **1 mark**

Input time slot $= \frac{Input\ data\ unit}{Input\ data\ rate} = \frac{3}{45 \times 10^3}$ **s** ---------- **1 mark**

Output time slot $= \frac{Input\ time\ slot}{No.of\ channels} = \frac{3}{45 \times 10^3 \times 7}$ **s = 0.0095 ms** ---------- **1 mark**

Part II: Read the questions carefully then answer all the questions [hint: show your step-by-step answer process to improve your grade score] (out of 12): [2 points each]

8. A device is sending out data at the rate of 10000 bps. [total 6 points]

   i. How long does it take to send out 10 bits?

Sol:

$\frac{10}{10000} = 1 \times 10^{-3} = 1ms$ ---------- **2 mark**

   ii. How long does it take to send out a single character (8 bits)?

Sol:

$\frac{8}{10000} = 8 \times 10^{-4} s$ ---------- **2 mark**

   iii. How long does it take to send a file of 100,000 characters?

Sol:

100,000 char $= 8 \times 100,000\ bits = 800,000$ **bit** ---------- **1 mark**

$\frac{800000}{10000} = 80$ **s** ---------- **1 mark**

9. A signal with 200 milliwatts power passes through 10 devices, each with an average noise of 2 microwatts. [total 4 points]

   i. What is the SNR?

Sol:

2 microwatts = 2×10^{-6} watt

Total average noise = $10 \times 2 \times 10^{-6}$ watt ---------- 1 mark

SNR = $\frac{Avg.\ Sig.\ Power}{Avg.\ Noise\ Power} = \frac{0.2}{10 \times 2 \times 10^{-6}}$ = 10,000 ---------- 1 mark

   ii. What is the SNR_{dB}?

Sol:

$SNR_{dB} = 10\ log_{10}\ SNR = 10\ log_{10}\ 10,000$ ---------- 1 mark

$= 10 \times 4 = 40\ dB$ ---------- 1 mark

10. We have a channel with a 1-MHz bandwidth. The SNR for this channel is 63. What is the appropriate bit rate?

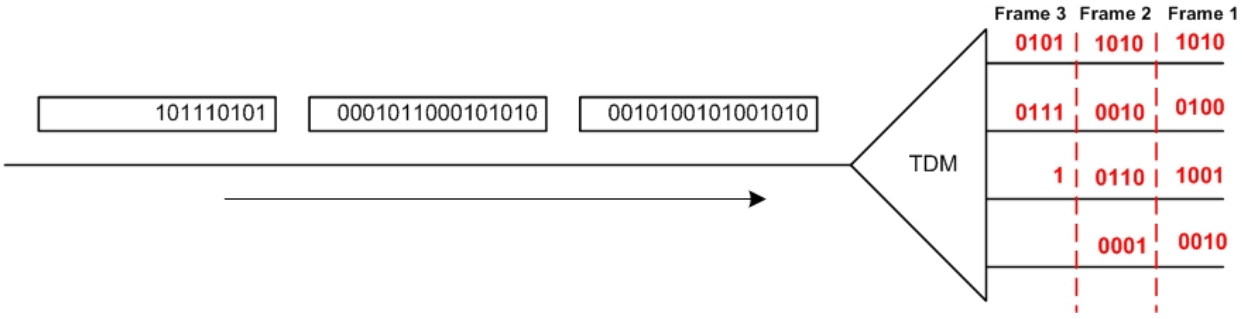
Sol:

Bit rate = Bandwidth $\times\ log_2\ (1 + SNR)$ ---------- 1 mark

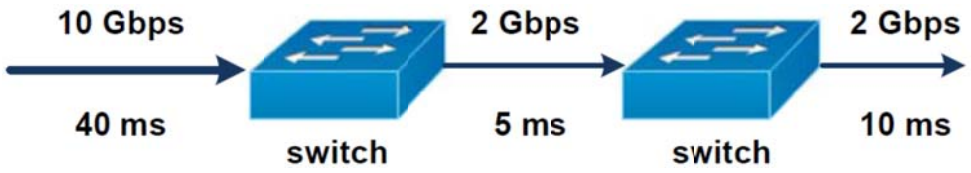
$= 1 \times 10^6 \times log_2\ (1 + 63) = 6\ Mbps$ ---------- 1 mark

Part III: Read the questions carefully then answer all the questions [hint: show your step-by-step answer process to improve your grade score] (out of 8): [2 points each]

11. The following figure shows a demultiplexer in a synchronous TDM. If the input slot is 16 bits long (no framing bits), what is the bit stream in each output? The bits arrive at the demultiplexer as shown by the arrows.



12. Consider the following network path with 3 links and 2 switches. The speed (bandwidth) and the delays (propagation delay) of the link are as indicated in the figure. Assume that the path is completely empty initially. [total of 6 points]



a. What is the total time required to transmit a 500 kB packet across this path? [assuming that the processing delay is zero]

Sol:

Packet size in bits = $500 \times 1024 \times 8 = 4096000\ bits$ ---------- ½ mark

Total transmission times = $\frac{File\ size}{Bandwidth} = \frac{4096000}{10\times10^9} + \frac{4096000}{2\times10^9} + \frac{4096000}{2\times10^9}$

$$= 0.0004096 + 0.00008192 + 0.00008192$$

$$= 0.00057344\ s$$ **---------- 1 mark**

Total propagation delays = 40 + 5 + 10 = 55 ms. ---------- ½ mark

Total time delays = queuing delay + transmission delay + processing delays + Propagation delay

= 0 + 0.57 ms + 0 + 55 ms = 55.57 ms ---------- ½ mark

b. What is the maximum number of bits of data that this network path carries at any moment?

Sol:

Total bandwidth delay product = $(10 \times 10^9 \times 40 \times 10^{-3}) + (2 \times 10^9 \times 5) + (2 \times 10^9 \times 5)$

$$= 420 \times 10^6 bits$$

$$= 52.5\ MB$$ **---------- 2 mark**

c. A MP3 file is roughly 4MB. How many MP3 files can the path carry at any moment.

Sol:

No. of MP3 files = $\frac{Bandwidth-delay\ product}{MP3\ file\ size} = \frac{52.5}{4} = 13.125$ MP3 files. ---------- 2 mark